amended by this amendment, Claim 1 recites "an electro-mechanical energy conversion element in contact with said elastic member, said electro-mechanical energy conversion element having a plurality of electrodes, a corresponding plurality of polarized regions formed by a polarization process of said electro-mechanical energy conversion element" to replace the objected-to phrase. The other claims have been similarly amended.

Claims 17 and 18 have been further objected to in that it is not understood what is mean by "the plurality of electrodes polarized in directions different from each other". In Claim 17 as amended by this amendment, the objected-to phrase has been replaced by "wherein the rigidity of portions of said elastic member located between adjacent electrodes of said plurality of electrodes having different directions of polarization from each other". The objected-to phrase in Claim 18 as amended by this amended has been deleted.

In view of the foregoing, it is believed that Claims 1 to 3, 13 to 15, 17, 18, 57 to 65 and 67 to 93 as amended by this amendment fully meet the requirements of 35 U.S.C. § 112, second paragraph.

Claims 1, 2, 13, 14, 57, 58, 61 to 68, 70, 71, 73, 75, 78, 79, 81, 82, 84, 86 and 89 to 93 have been rejected under 35 U.S.C. § 102(a), as anticipated by U.S. Patent No. 6,175,181 (Shirasaki), U.S. Patent No. 5,025,186 (Tsukada), and U.S. Patent No. 5,134,333 (Atsuta). The rejections of the claims over the cited art respectfully are traversed. Nevertheless, without conceding the propriety of the rejections, Claims 1-3, 13-15, 17, 18 and 86-93 have been amended to recite more clearly various novel features of the present

invention, with particular attention to the Examiner's comments. Support for the proposed amendments may be found in the original application. No new matter has been added.

Independent Claims 1 through 3 as amended by this amendment are directed to a vibration member having an elastic member that includes a driving portion and an electro-mechanical energy conversion element in contact with the elastic member. The electro-mechanical energy conversion member has plural electrodes, a corresponding plurality of polarized regions formed by a polarization process of the electro-mechanical energy conversion element and a modulus of elasticity profile generated by the polarization process. Application of an alternating signal to the electro-mechanical energy conversion element generates plural vibrations in the elastic member and a combination of the plural vibrations generates a driving vibration in the driving portion.

In Claim 1, the rigidity of portions of the elastic member located between the plural electrodes is set larger than the rigidity of other portions of the elastic member to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element.

In Claim 2, the cross-sectional area of portions of the elastic member between the plural electrodes is set larger than the cross-sectional area of other portions of the elastic member to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element.

In Claim 3, the density of portions of the elastic member located between the plural electrodes is set higher than the density of other portions of the elastic member to generated by the polarization process of the electro-mechanical energy conversion element.

Independent Claims 13 through 15 as amended by this amendment are directed to a vibration member having an annular or disc shape in which an elastic member has an annular or disc shape and includes a driving portion. An electro-mechanical energy conversion element having an annular shape is bonded to one surface of the elastic member. The electro-mechanical energy conversion member has plural electrodes, a corresponding plurality of polarized regions formed by a polarization process of the electro-mechanical energy conversion element and a modulus of elasticity profile generated by the polarization process. Application of an alternating signal to the electro-mechanical energy conversion element generates plural vibrations in the elastic member and a combination of the plural vibrations generates a driving vibration in the driving portion.

In Claim 13, the rigidity of portions of the elastic member located between the plural electrodes is set larger than the rigidity of other portions of the elastic member to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element.

In Claim 14, the cross-sectional area of portions of the elastic member between the plural electrodes is set larger than the cross-sectional area of other portions of the elastic member to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element.

In Claim 15, the density of portions of the elastic member located between the plural electrodes is set higher than the density of other portions of the elastic member to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element.

Independent Claims 91 and 92 as amended are directed to a vibration member in which an elastic member has an annular or disc shape and includes a driving portion. An electro-mechanical energy conversion element having an annular shape is bonded to one surface of the elastic member. The electro-mechanical energy conversion member has plural electrodes, a corresponding plurality of polarized regions formed by a polarization process of the electro-mechanical energy conversion element and a modulus of elasticity profile generated by the polarization process. Application of an alternating signal to the electro-mechanical energy conversion element generates plural vibrations in the elastic member and a combination of the plural vibrations generates a driving vibration in the driving portion.

In Claim 91, the rigidity of a portion of the elastic member adjacent to a portion located between adjacent electrodes of the plural electrodes is set large than the rigidity of other portions of the elastic member to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element.

In Claim 92, the cross-sectional area of a portion of the elastic member adjacent to a portion located between adjacent electrodes of the plural electrodes is set larger than that of other portions of the elastic member to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element.

In Applicant's view, <u>Shirasaki</u> discloses a vibration driven motor in which 2n (n is an integer) projections are formed per half wavelength on the driving surface of a

vibration member. The vibration member has an A driving electrode group (A_1 to A_8) and a B driving electrode group (B_1 to B_8) polarized at a $\lambda/2$ pitch so as to alternately have opposing expansion/contraction polarities with respect to a wavelength λ of a vibration wave to be excited, and $\lambda/4$-pitch vibration detection electrodes (S_A, S_B) and three ground common electrodes (G), which are arranged between the A and B electrode groups. The vibration detection electrodes (S_A, S_B) are arranged to have substantially loop positions of standing waves generated by the corresponding A and B driving electrode groups as their centers.

In accordance with the invention defined in Claims 1-3, 13-15, 91 and 92, the rigidity of portions of the elastic member located between the plural electrodes or adjacent to a portion located between adjacent electrodes is set larger than the rigidity of other portions to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element, the cross-sectional area of portions of the elastic member between the plural electrodes or of portions adjacent to a portion located between adjacent electrodes is set larger than the cross-sectional area of other portions of the elastic member to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element or the density of portions of the elastic member located between the plural electrodes is set higher than the density of other portions of the elastic member to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element. Advantageously, the adjustment of rigidity, cross-sectional area or density at portions between electrodes substantially solves

the problem of unevenness of vibration and amplitude that occur which deteriorates driving efficiency due to variations in the modulus of longitudinal elasticity between electrodes.

Shirasaki teaches that projections of an elastic member should be arranged at equal intervals or at substantially equal intervals over the entire periphery of the contact surfaces of the vibration member and refers to prior art Fig. 4B as having plural projections (5) the positional relationship of which per $\lambda/2$ is not specified with respect to the electrode arrangement of the piezo-electric element. In Fig. 4B, the only apparent difference between B2 and B3 and between A1 and A2 is the shift in phase of the projections. Accordingly, it is not seen that Shirasaki discloses or suggests anything concerning the rigidity, cross-sectional area or density of the portions of the elastic member located between the plural electrodes or adjacent to a portion located between adjacent electrodes is set larger than the rigidity of other portions which offsets differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element.

If, arguendo, it is assumed that the thickness of the elastic member between B2 and B3 is greater than the thickness between A1 and A2 in Fig. 4B, the Shirasaki arrangement would necessarily have a difference between the modulus of elasticity profile in section B2-B3 and the modulus of elasticity profile in section A1-A2. Accordingly, the assumed arrangement of Shirasaki could not in any manner teach or suggest the feature of the invention of rigidity, cross-sectional area or density of the portions of the elastic member located between the plural electrodes or adjacent to a portion located between adjacent electrodes being greater than other portions to offset differences in the modulus of

elasticity profile generated by the polarization process of the electro-mechanical energy conversion element. It is therefore believed that Claims 1-3, 13-15, 91 and 92 are completely distinguished from Shirasaki and are allowable thereover.

In Applicant's opinion, Tsukada discloses an ultrasonic motor adapted to generate a traveling wave by a piezoelectric element and a vibrator to which the piezoelectric element is bonded. The displacement of these parts due to the traveling wave is amplified by a comb-like projection of the vibrator, arranged alternately in the circumferential direction thereof, to frictionally drive a movable member engaged under pressure with the vibrator. The piezoelectric element is provided on one surface thereof with fan-shaped electrode patterns, the number of which is a multiple of 4, arranged at regular intervals in the circumferential direction thereof. The number of the fan-shaped electrode patterns and that of the vibrator have no common divisor with respect to each other, whereby the scatter of performance of ultrasonic motors, which is caused by a difference in the position in which the piezoelectric element and vibrator are bonded together, is eliminated to enable ultrasonic motors of uniform performance to be obtained.

As disclosed in Tsukada, the number of the electrode patterns and that of the comb-like projections of a vibrator (elastic member) have no common divisor with respect to each other, the efficiency of the ultrasonic motor is not influenced by a difference in the bonding portion of the piezoelectric element, and an ultrasonic motor having parts of little scatter of quality and a constant performance can be obtained. The Tsukada disclosure, however, is devoid of any teaching or suggestion of offsetting differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy

conversion element by making the rigidity, cross-sectional area or density of the portions of the elastic member located between the plural electrodes or adjacent to a portion located between adjacent electrodes greater than other portions as in the present invention.

As shown in Fig. 3 of Tsukada, the gap between electrodes 2A and 2B is centered underneath a tooth 1d while the other gaps in Fig. 3 are not so centered. As a result, the modulus of elasticity profile for the section including electrodes 2A and 2B and tooth 1d is different from the modulus of elasticity of the other sections in Fig. 3 and the modulus of elasticity profile of each section is different from that of the other sections due to the 1/12 pitch. As a result, there is introduced an unevenness of vibration and amplitude.

In contrast to Tsukada wherein rigidity changes are not at portions between electrodes or adjacent thereto, it is a feature of Claims 1-3, 13-15, 91 and 92 that the rigidity, the cross-sectional area or the density of the portions of the elastic member located between the plural electrodes or adjacent to a portion located between adjacent electrodes is made greater than that of other portions which offsets differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element so that each section of the elastic member is the same resulting in evenness of vibration and amplitude. It is therefore believed that Claims 1-3, 13-15, 91 and 92 as amended by this amendment are completely distinguished from Tsukada and are allowable thereover.

Atsuta, in Applicant's view, discloses a vibration type motor in which frequency signals differing in phase from each other are applied to an electro-mechanical energy conversion element disposed on a vibration member to thereby vibrate the vibration

member and drive a movable member by the vibration force. A monitoring portion for detecting the vibrated state of the vibration member is provided at a location avoiding a location at which the rigidity of the vibration member exhibits rigidity differing from the rigidity of the entire vibration member so that the vibrated state can be accurately detected.

As discussed with respect to Shirasaki and Tsukada, it is a feature of Claims 1-3, 13-15, 91 and 92 as amended by this amendment to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element by making the rigidity, cross-sectional area or density of the portions of the elastic member located between the plural electrodes or adjacent to a portion located between adjacent electrodes greater than that of other portions. Atsuta may teach an elastic member having a portion with rigidity different from rigidity at other portions. In Figs. 1A, 3A and 7A of Atsuta, however, the portions of different rigidity are not portions that are located between plural electrodes or portions adjacent to the portion located between adjacent electrodes as in Claims 1-3, 13-15, 91 and 92. For example, the rigidity for the configuration of Fig. 1A is lower over electrodes B4, B5 and B6 but there is no portion between the electrodes having a greater rigidity than other portions as in Claims 1-3 and 13-15 and there are no portions adjacent to portions located between adjacent electrodes that has greater rigidity than other portions as in Claims 91 and 92. Accordingly, it is not seen that Atsuta could possibly teach this feature of these claims. It is therefore believed that Claims 1-3, 13-15, 91 and 92 are completely distinguished from Atsuta and are allowable.

Independent Claims 17 and 18 as amended by this amendment are directed to a vibration member in which an elastic member has plural elastic member portions and a driving portion. An electro-mechanical energy conversion element is held and fixed between the plural elastic member portions. The electro-mechanical energy conversion member has plural electrodes, a corresponding plurality of polarized regions formed by a polarization process of the electro-mechanical energy conversion element and a modulus of elasticity profile generated by the polarization process. Application of an alternating signal to the electro-mechanical energy conversion element generates plural vibrations in the elastic member and a combination of the plural vibrations generates a driving vibration in the driving portion.

In Claim 17, The rigidity of portions of the elastic member located between adjacent electrodes of the plural electrodes having different polarities from each other is set larger than the rigidity of other portions of the elastic member to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element.

In Claim 18, portions of the elastic member located between the plurality of electrodes are cut out to offset differences in the modulus of elasticity profile generated by the polarization process of the electro-mechanical energy conversion element.

It is a feature of Claim 17 that the rigidity of a portion of the elastic member located between adjacent electrodes of the plural electrodes having different polarities from each other is set larger than the rigidity of other portions of the elastic member. As aforementioned with respect to Claims 1-3, 13-15, 91 and 92, any difference

in thickness in Shirasaki is not between adjacent electrodes of different polarities. The rigidity in Tsukada which may be greater at projection 1d than elsewhere does not result in the rigidity of the portions between adjacent electrodes being larger than other portions and the differences in rigidity in Atsuta do not provide greater rigidity at portions between adjacent electrodes than other portions. It is a feature of Claim 18 as amended by this amendment that portions of the elastic member located between the plurality of electrodes are cut out. It is not seen that any of the cited references teaches or suggests cut out portions between the plural electrodes as in Claim 18. Accordingly, Claims 17 and 18 as amended by this amendment are believed to be completely distinguished from any of the cited references and allowable.

Applicants submit that this Amendment After Final Rejection clearly places this application in condition for allowance. This Amendment was not earlier presented because Applicants believed that the prior Amendment placed the application in condition for allowance. Accordingly, entry of the instant Amendment, as an earnest attempt to advance prosecution and reduce the number of issues, is requested under 37 CFR 1.116.

Favorable reconsideration, withdrawal of the rejection set forth in the above-noted Office Action and an early Notice of Allowance are also requested.

Applicants' attorney, C. Phillip Wrist, may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should be directed to our address listed below.

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VERSION WITH MARKINGS TO SHOW CHANGES MADE TO THE CLAIMS

1. (Twice Amended) A vibration member comprising:

an elastic member including a driving portion;[:] and

an electro-mechanical energy conversion element in contact with said elastic member, said electro-mechanical energy conversion element having a plurality of electrodes, a corresponding plurality of polarized regions formed by a polarization process of said electro-mechanical energy conversion element, and a modulus of elasticity profile generated by the polarization process, where application of an alternating signal to said electro-mechanical energy conversion element generates a plurality of vibrations in said elastic member, and where a combination of the plurality of vibrations generates a driving vibration in said driving portion,

wherein a rigidity of portions [a portion] of said elastic member located between said plurality of electrodes is set larger than a rigidity of other portions of said elastic member so as to offset differences in the modulus of elasticity profile generated by the polarization process of said electro-mechanical energy conversion element.

2. (Twice Amended) A vibration member comprising:

an elastic member including a driving portion; and

an electro-mechanical energy conversion element in contact with said elastic member, said electro-mechanical energy conversion element having a plurality of electrodes, a corresponding plurality of polarized regions formed by a polarization process of said electro-mechanical energy conversion element, and a modulus of elasticity profile generated by the polarization process, where application of an alternating signal to said electro-mechanical energy conversion element generates a plurality of vibrations in said elastic member, and where a combination of the plurality of vibrations generates a driving vibration in said driving portion,

wherein a cross-sectional area of portions [a portion] of said elastic member located between said plurality electrodes is set larger than [that] a cross-sectional area of other portions of said elastic member so as to offset differences in the modulus of elasticity profile generated by the polarization process of said electro-mechanical energy conversion element.

3. (Twice Amended) A vibration member comprising:

an elastic member including a driving portion; and

an electro-mechanical energy conversion element in contact with said elastic member, said electro-mechanical energy conversion element having a plurality of electrodes, a corresponding plurality of polarized regions formed by a polarization process of said electro-mechanical energy conversion element, and a modulus of elasticity profile generated by the polarization process, where application of an alternating signal to said electro-mechanical energy conversion element generates a plurality of vibrations in said elastic member, and where a combination of the plurality of vibrations generates a driving vibration in said driving portion,

wherein a density of portions [a portion] of said elastic member located between said plurality of electrodes is set higher than a density of other portions [portion] of said elastic member so as to offset differences in the modulus of elasticity profile generated by the polarization process of said electro-mechanical energy conversion element.

13. (Twice Amended) A vibration member having an annular or disc shape, comprising:

an elastic member including a driving portion, and having an annular or disc shape; and

an electro-mechanical energy conversion element having an annular shape and bonded to one surface of said elastic member, said electro-mechanical energy

conversion element having a plurality of electrodes, a corresponding plurality of polarized regions formed by a polarization process of said electro-mechanical energy conversion element, and a modulus of elasticity profile generated by the polarization process, where application of an alternating signal to the electro-mechanical energy conversion element generates a plurality of vibrations in said elastic member, and where a combination of the plurality of vibrations generates a driving vibration in said driving portion,

wherein a rigidity of portions [a portion] of said elastic member located between said plurality of electrodes is set larger than a rigidity of other portions [portion] of said elastic member so as to offset differences in the modulus of elasticity generated by the polarization process of said electro-mechanical energy conversion element.

14. (Twice Amended) A vibration member having an annular or disc shape, comprising:

an elastic member including a driving portion, and having an annular or disc shape; and

an electro-mechanical energy conversion element having an annular shape and bonded to one surface of said elastic member, said electro-mechanical energy conversion element having a plurality of electrodes, a corresponding plurality of polarized regions formed by a polarization process of said electro-mechanical energy conversion element, and a modulus of elasticity profile generated by the polarization process, where

application of an alternating signal to said electro-mechanical energy conversion element generates a plurality of vibrations in said elastic member, and where a combination of the plurality of vibrations generates a driving vibration in said driving portion,

wherein a cross-sectional area of portions [a portion] of said elastic member located between said plurality of electrodes is set larger than a cross-sectional area of other portions of said elastic member so as to offset differences in the modulus of elasticity profile generated by the polarization process of said electro-mechanical energy conversion element.

15. (Twice Amended) A vibration member having an annular or disc shape, comprising:

an elastic member including a driving portion, and having an annular or disc shape; and

an electro-mechanical energy conversion element having an annular shape and bonded to one surface of said elastic member, said electro-mechanical energy conversion element having a plurality of electrodes, a corresponding plurality of polarized regions formed by a polarization process of said electro-mechanical energy conversion element, and a modulus of elasticity profile generated by the polarization process, where application of an alternating signal to the electro-mechanical energy conversion element

generates a plurality of vibrations in said elastic member, and where a combination of the plurality of vibrations generates a driving vibration in said driving portion,

wherein a density of portions [a portion] of said elastic member located between said [the] plurality of electrodes is set higher than a density of other portions of said elastic member so as to offset differences in the modulus of elasticity profile generated by the polarization process of said electro-mechanical energy conversion element.

17. (Twice Amended) A vibration member comprising:

an elastic member including plural elastic member portions and a driving portion; and

an electro-mechanical energy conversion element held and fixed between said plural elastic member portions, said electro-mechanical energy conversion element having a plurality of electrodes, a corresponding plurality of polarized regions formed by a polarization process of said electro-mechanical energy conversion element, and a modulus of elasticity profile generated by the polarization process, where application of an alternating signal to said electro-mechanical energy conversion element generates a plurality of vibrations in said elastic member, and where a combination of the plurality of vibrations generates a driving vibration in said driving portion of said elastic member,

wherein the [a] rigidity of [a portion] portions of said elastic member located between adjacent electrodes of said [the] plurality of electrodes having [polarized in directions] different directions of polarization from each other is set larger than the [a] rigidity of other portions [portion] of said elastic member so as to offset differences in the modulus of elasticity profile generated by the polarization process of said electro-mechanical energy conversion element.

18. (Twice Amended) A vibration member comprising:

an elastic member including plural elastic member portions and a driving portion; and

an electro-mechanical energy conversion element held and fixed between said plural elastic member portions, said electro-mechanical energy conversion element having a plurality of electrodes, a corresponding plurality of polarized regions formed by a polarization process of said electro-mechanical energy conversion element, and a modulus of elasticity profile generated by the polarization process, where application of an alternating signal to said electro-mechanical energy conversion element generates a plurality of vibrations in said elastic member, and where a combination of the plurality of vibrations generates a driving-vibration in said driving portion,

wherein portions [a portion] of said elastic member located between said plurality of electrodes are [polarized in directions different from each other is] cut out so as to offset differences in the modulus of elasticity generated by the polarization process of said electro-mechanical energy conversion element.

86. (Amended) A vibration member according to Claim 14, wherein said elastic member has a plurality of grooves for enlarging displacement of said driving portion, and a groove for enlarging displacement located between adjacent electrodes of said electrodes is set shallower than other grooves for enlarging displacement.

87. (Amended) A vibration member according to Claim 15, wherein said elastic member is made of a material having pores, and a number of pores in a portion of said elastic member located between adjacent electrodes of said plurality of electrodes is set less than that in other portions of said elastic member.

88. (Amended) A vibration member according to Claim 15, wherein said elastic member is made of a material having pores, and the pores in a portion of said elastic member located between adjacent electrodes of said plurality of electrodes are

impregnated with a material having a melting point which is lower than that of other material of said elastic member.

89. (Amended) A vibration member according to Claim 13, wherein said electro-mechanical energy conversion element has a plurality of electrodes provided in a peripheral direction, and a width in a radial direction of a portion between adjacent electrodes of the plurality of electrodes is set larger than that of an electrode.

90. (Amended) A vibration member according to Claim 14, wherein said electro-mechanical energy conversion element has a plurality of electrodes provided in a peripheral direction, and a width in a radial direction of a portion between adjacent electrodes of the plurality of electrodes is set larger than that of an electrode.

91. (Amended) A vibration member comprising:

an elastic member including a driving portion, and having an annular or disc shape; and

an electro-mechanical energy conversion element having an annular shape and bonded to one surface of said elastic member, said electro-mechanical energy conversion element having a plurality of electrodes, a corresponding plurality of polarized

regions formed by a polarization process of said electro-mechanical energy conversion element, and a modulus of elasticity profile generated by the polarization process, where application of an alternating signal to said electro-mechanical energy conversion element generates a plurality of vibrations in said elastic member, and a combination of the plurality of vibrations generates a driving vibration in said driving portion,

wherein a rigidity of a portion of said elastic member adjacent to a portion located between adjacent electrodes of said plurality of electrodes is set larger than a rigidity of other portions of said elastic member so as to offset differences in the modulus of elasticity profile generated by the polarization treatment of said electro-mechanical energy conversion element.

92. (Amended) A vibration member comprising:

an elastic member including a driving portion, and having an annular or disc shape; and

an electro-mechanical energy conversion element having an annular shape and bonded to one surface of said elastic member, said electro-mechanical energy conversion element having a plurality of electrodes, a corresponding plurality of polarized regions formed by a polarization process of said electro-mechanical energy conversion element, and a modulus of elasticity profile generated by the polarization process profile,

where application of an alternating signal to said electro-mechanical energy conversion element generates a plurality of vibrations in said elastic member, and a combination of the plurality of vibrations generates a driving vibration in said driving portion,

wherein a cross-sectional area of a portion of said elastic member adjacent to a portion located between adjacent electrodes of said plurality of electrodes is set larger than that of other portions of said elastic member so as to offset differences in the modulus of elasticity generated by the polarization process of said electro-mechanical energy conversion element.

93. (Amended) A vibration member according to Claim 92, wherein said elastic member has a plurality of grooves for enlarging displacement of said driving portion, and a groove for enlarging displacement located between adjacent electrodes of said plurality of electrodes is set shallower than other grooves for enlarging displacement.